Space Weather Technical Forecast

Issued on Friday, 02 December 2022 at 01:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storm intervals days 1 and 3 (2nd and 4th). Chance of M-flares. Active high energy electron fluence. CME arrival possible late day 2 or day 3 (3rd or 4th), but low confidence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with a long period M1.0 flare peaking at 01/0721 UTC, observed from AR3152, now diminished to Axx/Alpha. Several C-class flares have also been observed, the largest of these a C2.9 peaking at 01/1911 UTC, from AR3153. This region is the largest on the disc, and potentially magnetically complex, although analysis is still uncertain due to the region's proximity to the southeast limb and image foreshortening. The remaining regions on the disc, two numbered and one new region, are all magnetically simple, mostly small and weak.

A moderately fast CME was observed from the M1.0 flare of AR3152, but is not expected to be Earth directed.

Solar Wind / Geomagnetic Activity: The solar wind as measured by ACE and DSCOVR at L1, exhibited fast wind conditions due to the HSS of CH49 and CH51. Wind speeds have been Elevated to Strong, peaking at 685 km/s at 01/0159 UTC. Density was generally around average levels until late in the day, then increased slightly to become above average, peaking at 18 ppcc at 01/2242 UTC. The total IMF strength, Bt, was initially Moderate, 10-12 nT, but declined to be weak at below 7nT from 01/0945 UTC. The north-south component, Bz, initially oscillated between +11 nT and -10 nT, then settled to become mainly weakly negative. Phi angle was predominantly positive (away from the Sun). Geomagnetic activity was Unsettled to Active (Kp 3-4) with one period of G1/Minor geomagnetic storms (01/0300-0600 UTC).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES-16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES-16 was initially at moderate levels, then increased to high levels from 01/1415 UTC and through the rest of the day, peaking at 3825 pfu at 01/1840 UTC. The associated 24 hour Fluence was mostly above the Active (1e8 integrated pfu), but temporarily dropped below the threshold in the evening. Observed fluence at 02/0000 UTC was 1.07e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, but with a chance of rising to Moderate with an ongoing potential for M-flares, primarily from AR3153 in the southeast.

Solar Wind / Geomagnetic Activity: Slow CME arrivals are possible, mainly early day 3 (4th), due to a filament eruption on the 29th, although confidence is low with the timing. The CME from the M1-flare on the 1st is currently not expected to be Earth directed.

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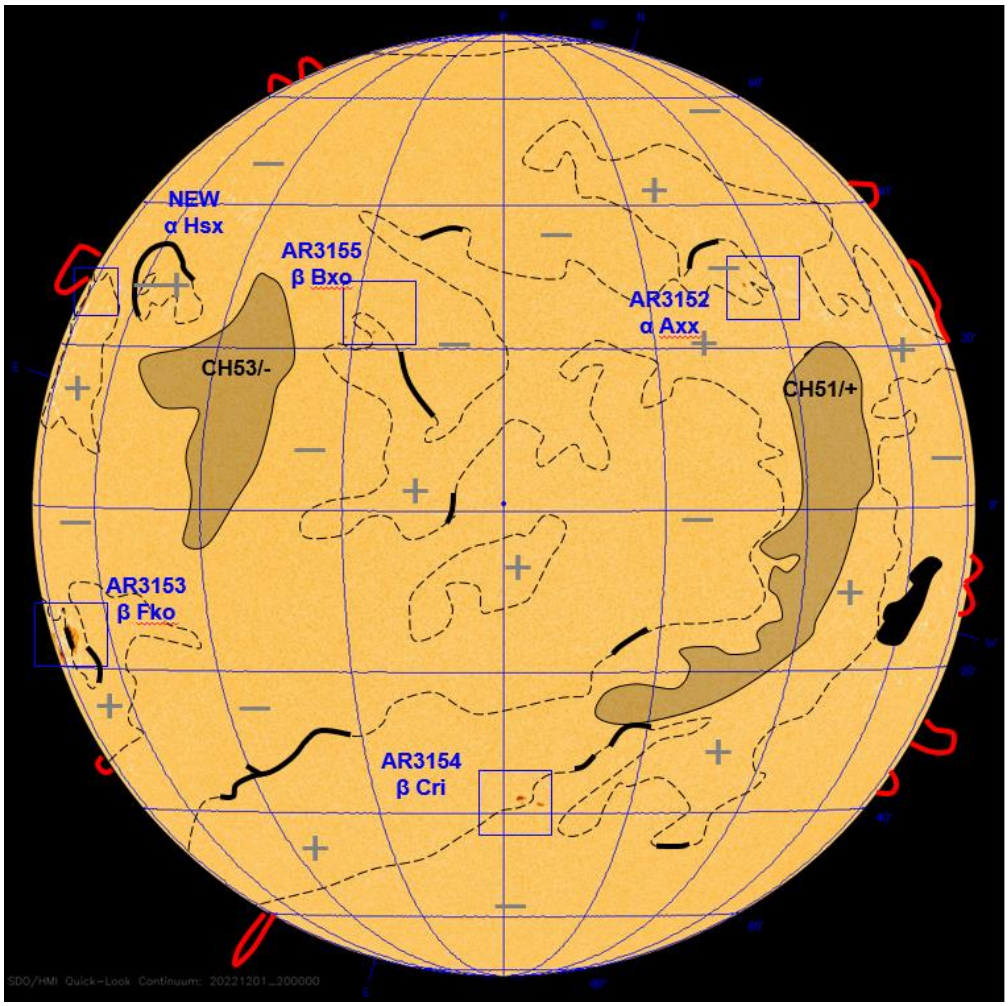
Otherwise, ongoing fast winds from CH49/+ and CH51/+ are expected to gradually decline through the period. Unsettled to Active (Kp 3-4) geomagnetic conditions, with an ongoing chance of further G1/Minor storm intervals, are expected for days 1 and 3 (2nd and 4th), with Quiet to Unsettled (Kp 2-3), and a chance of Active intervals, for days 2 and 4 (3rd and 5th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16, is currently at background levels and is expected to remain at this level throughout. High energy electron flux (greater than 2 MeV), as observed by GOES16, is expected to remain predominantly above the High threshold throughout. Fluence levels are currently above the Active (1e8 integrated pfu) fluence threshold, and are expected to remain mainly above Active throughout.

Figure 1. Solar Analysis Valid 01/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

A filament eruption on 29 Nov, and its associated CMEs have been assessed as slow, but with the possibility of Earth-directed components, although this is low confidence. Any arrival is most likely to occur early day 4 (4th), perhaps very late day 3 (3rd). The CME from the M1 flare of AR3152 at 01/0721 UTC has yet to be fully assessed.
Ongoing fast wind environment is expected to continue today (2nd), due to the high speed streams (HSS) of CH49 and CH51. Current elevated to strong solar winds of around 550-610 km/s are forecast to only gradually fade through the period. MOSWOC Enlil is currently indicating a slight decline to around 500 km/s by the end of tomorrow (3rd). The 27-day persistence also indicates a gradual decline, albeit slightly faster, with solar winds around 400 km/s by late tomorrow. However, as CH51 is a larger feature on this rotation this supports to the forecast from the Enlil model. In addition to the HSS slow CME arrivals are possible, mainly early day 3 (4th), due to a filament eruption on the 29th, although confidence is low with the timing.

Unsettled to Active (Kp 3-4) geomagnetic conditions, with an ongoing chance of further G1/Minor storm intervals, are expected for days 1 and 3 (2nd and 4th), with Quiet to Unsettled (Kp 2-3), and a chance of Active intervals, for days 2 and 4 (3rd and 5th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	20	30	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
30/1246	Partial	Filament	SE	300 km/s	04/0600 +/-9 hours	Limited shock 2nd part of CME Low confidence
30/0730	Partial	Filament	SE	320 km/s	04/0600 +/-9 hours	Limited shock 1st part of CME Low confidence

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Figure 2: Latest MOSWOC Enlil model, showing potential CME arrival early on the 4th.

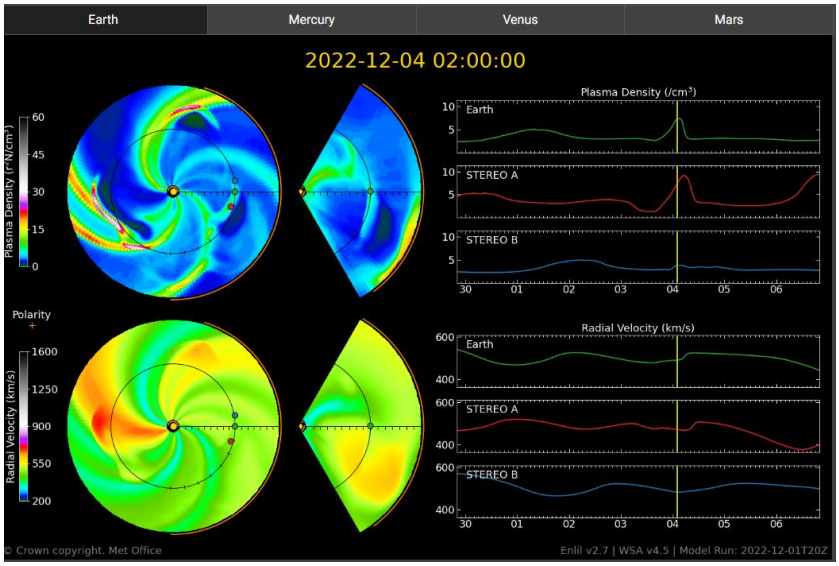
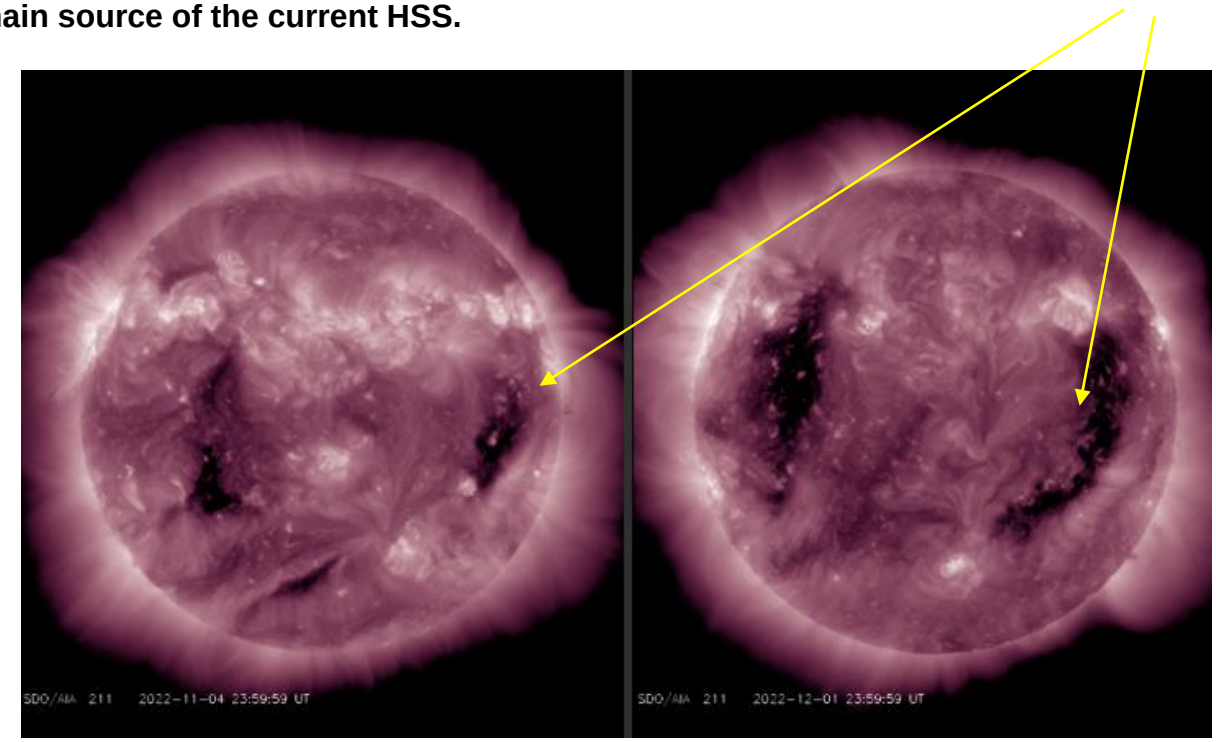


Figure 3: Latest SDO/AIA 211 (left) and previous rotation (right) showing CH51, the main source of the current HSS.



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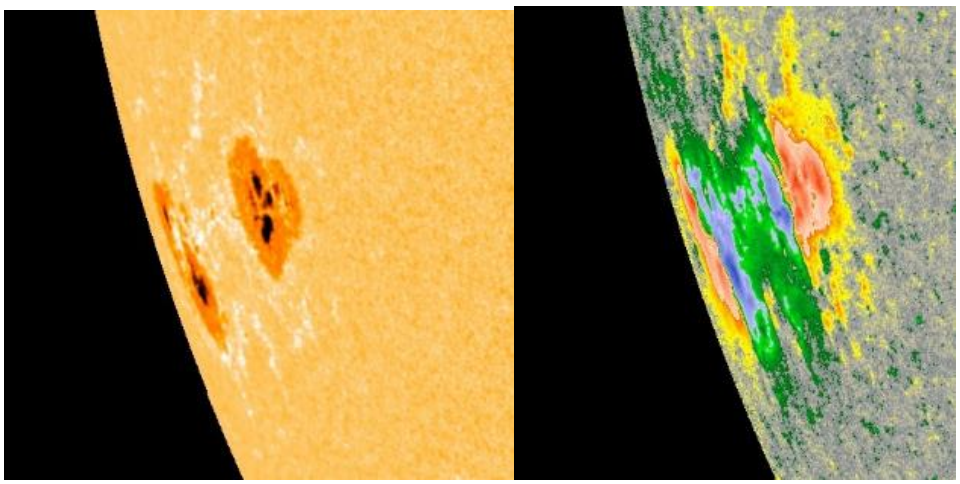
Radio Blackouts - X-Ray Flares:

The main source of this potential significant flare activity is from newly numbered AR3153 rotating over the southeast limb. This region has currently been assessed as Fko/beta, AR3153 remains tricky to analyse due to its close proximity to the east limb and so image foreshortening. However, it appears to be a large region with asymmetric penumbra on both the leading and trailing spots, with a potentially complex magnetic configuration and possibly a delta spot. AR3152 persists as a simple unipolar spot, with a slight reduction in area. AR3154 remains a small bipolar region in the southern centre disc, with a very slight decay to become a Cri. AR3155 has recently been numbered, a small, weak and stable bipolar region. The new region near the northeast limb appears to be a mature unipolar spot. Further new regions may rotate onto the visible disc over the next 4 days.

Solar activity has been at Moderate levels during the past 24 hours due to a long period M1-flare from AR3152, peaking 01/0721 UTC. Further flaring from this region is considered unlikely, with the main flare risk now from AR3153. There is a chance of further M-flares, and a slight chance of X-flares, although this risk will need reassessing as AR3153 moves into a clearer view.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	25	25	25	25
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: Recent SDO/HMI intensitygram (left) and magnetogram (right) images of AR3153.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16, is currently at background levels and is expected to remain at this level throughout the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

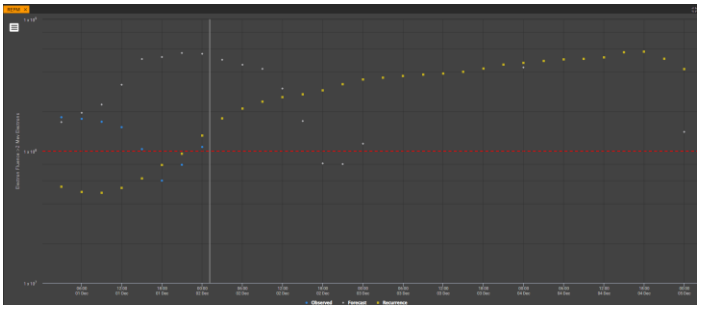
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV), as observed by GOES16, is currently at High levels (above 1000 pfu). Due to the strength of the current HSS the high energy electron flux is expected to remain predominantly at High levels, with only potential brief dips below due to geomagnetic activity increasing, this most likely early day 3 (4th).

Fluence levels are currently above the Active (1e8 integrated pfu) and are likely to increase through the following days as the HSS wanes. Confidence is high that the fluence will remain predominantly above Active, perhaps briefly falling below if geomagnetic activity increases with a CME arrive. The REFM is currently over-estimating the fluence levels, and does forecast the fluence remaining above Active for much the of the next 3 days. However, the trend of the REFM is dismissed, with an initial rising trend expected instead.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	100	90	100
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	5	2	5

Figure 5: Latest MOSWOC REFM model.



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